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INFO MISSILE TECHNOLOGY CONTROL REGIME COLLECTIVE

C O N F I D E N T I A L STATE 146965

SIPDIS

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TAGS: MTCRE ETTC KSCA MNUC PARM TSPA FR UK DA

SUBJECT: MISSILE TECHNOLOGY CONTROL REGIME (MTCR): U.S. PAPER ON MISSILE-USEFUL CHEMICALS

Classified By: ISN/MTR Director Pam Durham.
Reasons: 1.4 (B), (D).

¶1. (U) This is an action request. Please see paragraph 2.

¶2. (C) ACTION REQUEST: Request Embassy Paris provide the interagency cleared paper on "Missile Useful Chemicals that are not MTCR-controlled" in paragraph 3 below to the French Missile Technology Control Regime (MTCR) Point of Contact (POC) for distribution to all Partners. Also request Embassy London provide paper to the MTCR Information Exchange (IE) Co-Chair (John Andrews), and Embassy Copenhagen provide paper to the Danish MTCR Plenary Chair. Info addressees also may provide to host government officials as appropriate. In delivering paper, posts should indicate that the U.S. is sharing this paper as part of our preparation for the Information Exchange that will be held in conjunction with the October 2-6, 2006 MTCR Plenary. NOTE: Additional IE papers will be provided via septels in the coming weeks. END NOTE.

¶3. BEGIN TEXT OF PAPER:

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Missile-Useful Chemicals That Are Not MTCR-Controlled

Introduction
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Probably the most difficult materials to control from a ballistic missile standpoint are many of the chemicals used to manufacture and process solid propellants. In general, solid propellants are a blended chemical mixture of oxidizer and fuel substances held together by polymeric binders. At times, the fuel and the binder may be the same. Additionally, several agents may be used to enhance the bonding of the binders with propellant ingredients and small amounts of additives may be used to alter the propellant's physical properties. While most of the major ingredients in solid propellants such as the binders Hydroxyl-terminated polybutadiene (HTPB), Carboxyl-terminated polybutadiene (CTPB), Polybutadiene-acrylic acid-acrylonitrite terpolymer (PBAN), etc. and oxidizers such as ammonium perchlorate are controlled, there are many chemicals used as minor ingredients that are not controlled because of their widespread use in non-missile related industries. The following are several chemicals grouped by their use or category in solid propellants that are not controlled by the MTCR, but are often used in the propellant production process.

Binders
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The following are binders that can be used or have been used

in solid propellants, but have widespread use in other industries such as polyurethane rubbers, caulks, sealants, etc. All of these materials are produced in the U.S., Europe, Russia, and many third world countries with a basic chemical industry.

1) Polypropylene glycol (PPG). PPG is one of the earliest binders used in solid propellants. Its major use is in the polyurethane rubber and sealants industries, but it is quite suitable for use as a binder when HTPB or other more state-of-the-art binders are not available.

2) Polydiethyleneglycol adipate or polyglycol adipate (PGA). As with PPG, the major use of this binder is in the polyurethane rubber industry. Its main use in modern solid propellants is as a binder for high performance nitrate ester (nitroglycerin, butanetriol trinitrate) plasticized propellants. These types of propellants are used in the U.S. Trident C-4 missile.

3) Polycaprolactone (PCP). PCP is very similar to PGA, with the main use being the polyurethane rubber and sealants industries. Its main use in solid propellants is as a binder for high performance nitrate ester plasticized propellants.

4) Polyethylene glycol (PEG). PEG is the polyether that is used as a binder in some of the most advanced high performance propellants. Commonly referred to as NEPE (nitrate ester polyether) propellants, these propellants are used in the Trident II D-5 SLBM. This binder has many uses in the plastics, pharmaceutical and food packaging industries, and of the millions of pounds of this material produced in the U.S. and world-wide, only a fraction of this production is devoted to military purposes.

5) Polyvinyl chloride (PVC). This is one of the earlier binders used in solid propellant production and is still used in some countries for solid propellant production. Propellants with this binder are generally low in performance and not suitable for long and medium range ballistic missile production. Its main use is in the vinyl plastics industry, namely plastic lawn furniture, plastics pipe, and other injection molded plastics.

6) Hydroxyl terminated poly ethers (HTPE), hydroxyl terminated poly esters (HTPS), and hydroxyl terminated poly acetylene (HTPA). These binders are similar to HTPB, but with a higher oxygen content. Polytetrahydrofuran polyethylene glycol (TPEG), like PEG, is a HTPE binder that is currently being used in several missile systems and has similar or improved properties compared to HTPB.

Cross-linkers or Curatives
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Cross-linkers are important materials used to improve the bond between the oxidizer and binder in the solid propellant mixture. Any difunctional or polyfunctional isocyanate can be used to cross-link or cure HTPB, PPG, PGA, PCP, or PEG binders. However, the only cross-linker controlled by the MTCR is Isophorone Diisocyanate (IPDI). IPDI is best when used with HTPB and not used with any of the other binder systems mentioned. While there are many di- and polyfunctional isocyanates available, only 3 or 4 are of any importance to the solid propellant industry. The major use of all isocyanates is the polyurethane rubber/polyurethane foam industries and the plastics industries. Most are available worldwide. Any isocyanate going to an entity connected to solid propellant production should be questioned.

1) Toluene Diisocyanate (TDI). TDI is probably the most widely produced diisocyanate in terms of quantity in the world. Millions of pounds go into the polyurethane rubber/foam industry and it is the primary material used by that industry. Other lesser used isocyanates can be used to impart differing properties to the rubber or foam, but TDI remains the largest in terms of volume. From a propellant standpoint, it is an excellent cross-linker for PGA, PCP, and

PPG propellants, while IPDI is not suitable for these types of propellants. TDI is also used extensively with HTPB when IPDI is not available and is often used by other countries for this very reason. Quite acceptable HTPB propellant can be obtained with TDI.

2) Hexamethylene Diisocyanate (HMDI or HDI). This material is often used in place of TDI where long propellant casting times are involved. HMDI has a slower rate of reaction than TDI and thus delays the time at which the propellant begins to harden. As with TDI, it has many more uses in other industries. It is also an acceptable substitute for IPDI in HTPB propellants.

3) Dimeryl Diisocyanate (DDI). DDI is often used with HTPB propellants because of its tendency to produce a propellant with a lower burning rate than an equivalent propellant with IPDI. It is not used with any binder other than HTPB. Its main use is in the rubber sealants industry with hydrocarbon rubbers such as the HTPB family.

4) Isonate 143. This is a polyfunctional isocyanate based on TDI and is used in place of TDI to produce harder, higher modulus rubbers. It can be used with HTPB or any of the polyester/polyether binders with hydroxyl functionality.

Plasticizers
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Plasticizers are important materials in the solid propellant industry, and are used to improve the flexibility and processing characteristics of the propellant. As with other materials used in propellants, they are used in the rubbers and plastics industries. In general, they are usually esters of difunctional organic acids. Another class of plasticizers called energetic plasticizers are used in high performance propellants. One family of this type of plasticizer is the nitrate esters, which are organic esters of nitric acid. This family includes nitroglycerin, butanetriol trinitrate (BTTN), diethylene glycol dinitrate (DEGDN) and triethyleneglycol dinitrate (TEGDN), some of which are controlled by the MTCR. The following are plasticizers which are not controlled by the MTCR:

1) Dioctyl adipate or di-2-ethylhexyl adipate (DOA). This plasticizer is commonly used with hydrocarbon binders such as HTPB, CTPB and PBAN. It can also be used with PVC binders. As mentioned above, this material is most widely used in the plastics and rubber industries.

2) Dioctyl sebacate or di-2-ethylhexyl sebacate (DOS). This material is often used in place of DOA and is used with hydrocarbon binders such as HTPB, CTPB, and PBAN. It is also widely used in the plastics and rubber industries.

3) Dioctyl azelate or di-2-ethylhexyl azelate (DOZ). This material is often used in place of DOA and is used with hydrocarbon binders such as HTPB, CTPB, and PBAN. It is also widely used in the plastics and rubber industries.

4) Dibutyl Phthalate (DPB). This is the ester of a difunctional aromatic acid (phthalic acid) and is generally not soluble in hydrocarbon binders. It is often used in small quantities in doublebase propellants but has been used in composite propellants. Its primary use is as an insect repellant in clothing.

Oxidizers
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Oxidizers are one of the most important constituents of solid rocket propellant and can be anywhere from 60 to 85 percent of the total propellant formulation. By far the most important oxidizer for solid propellants is ammonium perchlorate (AP), which is controlled by the MTCR. Other important oxidizing substances include ammonium dinitramide (ADN), hydrazinium nitroformate (HNF), and various nitramines such as cyclotetramethylene-tetranitramine (HMX),

cyclotrimethylene-trinitramine (RDX), and hexanitrohexaazaisowurtzitane (HNIW) or CL-20. These materials are all controlled by the MTCR. Other oxidizers are available which are not controlled, but they are generally not suitable for ballistic missiles purposes because of their low performance. Many of these materials can be used however in propellants for short range or battlefield rockets. These oxidizers are:

1) Potassium perchlorate
2) Potassium nitrate
3) Ammonium nitrate
4) Hydroxylammonium nitrate
5) Hydroxylammonium perchlorate

Fuels
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The fuels used in solid propellants are generally powdered metals, the most important being aluminum powder. Most of the useful metal fuels are covered by the MTCR and include aluminum, beryllium, zirconium and magnesium. The MTCR also covers alloys of these metals. Boron is also controlled but is generally not used in composite solid propellant. Another class of very high performance fuels is the metal hydrides. The reason for their high performance is that they combine the metal fuel with the highest performing fuel, hydrogen. The important metal hydrides from a solid propellant standpoint are as follows:

1) Beryllium hydride
2) Aluminum hydride
3) Lithium aluminum hydride

The use of these fuels in the past has been very limited because of the difficulty in handling them. All are very strong reducing agents, which means that they will react rapidly with any source of oxygen or other oxidizing agent. All react rapidly with water to produce hydrogen which creates an explosion hazard. They can be used very successfully in solid propellants if the proper precautions, such as protection from air and moisture, are taken.

Summary
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There are many other chemicals and classes of chemicals used in small amounts to improve service life, modify burning rate or ballistic properties, improve physical properties, etc., but the majority of these are already controlled by the MTCR. Most of these materials are not a necessity for producing solid propellant or are used in such small amounts that it is impossible to track their procurement. What has been attempted here is to list some of the more important constituent components of solid rocket propellants that are not controlled by the MTCR and which could be of interest to proliferators.

END TEXT OF PAPER.

¶4. (U) Please slug any reporting on this or other MTCR issues for ISN/MTR.
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